CLAIMS

We claim:

1. A fluid delivery and removal channel passage structure integrally associated with an electrode structure of a fuel cell system, comprising:

a fluid delivery channel disposed across a first face of the electrode structure;

a fluid removal channel disposed across a second face of the electrode structure, wherein the second face opposes the first face; and

a porous bulk matrix fluid transport layer interposed between the fluid delivery channel and the fluid removal channel, wherein the porous bulk matrix fluid transport layer is adapted to hydrodynamically flow a gas or liquid therethrough, and wherein the porous bulk matrix fluid transport layer is in fluid communication with the fluid delivery and the fluid removal channels.

2. The fluid delivery and removal channel passage structure of claim 1, wherein the fuel cell system is a direct liquid feed fuel cell system.

3. The fluid delivery and removal channel passage structure of claim 1, wherein the electrode structure comprises silicon.

4. The fluid delivery and removal channel passage structure of claim 1, wherein the porous bulk matrix fluid transport layer comprises porous silicon.

5. The fluid delivery and removal channel passage structure of claim 1, wherein the porous bulk matrix fluid transport layer is defined by an array of linear acicular pores etched into a silicon substrate.

6. The fluid delivery and removal passage structure of claim 5, wherein the array of linear acicular pores defines inner pore surfaces, wherein the inner pores surfaces have catalyst particles uniformly dispersed thereon.

7. The fluid delivery and removal channel passage structure of claim 1, wherein the porous bulk matrix fluid transport layer comprises a sol-gel.

8. A fluid delivery and removal channel passage structure associated with an electrode structure of a fuel cell system, characterized in that the fluid delivery and removal passage structure comprises an inlet passage and an outlet passage separated by a porous bulk matrix fluid transport layer, wherein the porous bulk matrix fluid transport layer is adapted to hydrodynamically flow a gas or liquid therethrough, and wherein the porous bulk matrix fluid transport layer is in fluid communication with the inlet passage and the outlet passage.

9. The fluid delivery and removal channel passage structure of claim 8, wherein the fuel cell system is a direct methanol fuel cell system.

10. The fluid delivery and removal channel passage structure of claim 8, wherein the electrode structure comprises silicon.

11. The fluid delivery and removal channel passage structure of claim 8, wherein the porous bulk matrix fluid transport layer comprises porous silicon.

12. The fluid delivery and removal channel passage structure of claim 8, wherein the porous bulk matrix fluid transport layer is defined by an array of linear acicular pores etched into a silicon substrate.

13. The fluid delivery and removal passage structure of claim 12, wherein the array of linear acicular pores defines inner pore surfaces, wherein the inner pores surfaces have catalyst particles uniformly dispersed thereon.

14. The fluid delivery and removal channel passage structure of claim 8, wherein the porous bulk matrix fluid transport layer comprises a sol-gel.

15. A fluid transport passageway structure integrally associated and in combination with a bi-polar electrode plate assembly of a fuel cell system, characterized in that bi-polar electrode plate assembly comprises an anodic electrode structure bonded together with an opposing cathodic electrode structure, wherein the anodic electrode structure comprises:

one or more anodic fluid delivery channels positioned on a first side of the anodic electrode structure;

one or more anodic fluid removal channels positioned on a second side of the anodic electrode structure, wherein the second side is substantially parallel to the first side of the anodic electrode structure; and

one or more porous bulk matrix anodic fluid transport regions, wherein each porous bulk matrix anodic fluid transport region is positioned in between at least (i) one of the one or more anodic fluid delivery channels, and (ii) one of the one or more cathodic fluid removal channels, and wherein each porous bulk matrix anodic fluid transport region is in fluidic communication with at least one of the one or more anodic fluid delivery channels and at least one of the one or more anodic fluid removal channels; and wherein the cathodic electrode assembly comprises:

at least one porous bulk matrix cathodic fluid transport region in fluidic communication with an inlet passage and an outlet passage, wherein the porous bulk matrix cathodic fluid transport region is adapted to hydrodynamically flow a gas or liquid therethrough, and wherein the porous bulk cathodic matrix fluid transport region is in fluid communication with the inlet passage and the outlet passage.

16. A plurality of fluid transport and flow channel passageway structures integrally associated with a fuel cell electrode stack assembly of a fuel cell system, comprising:

a first end cap assembly having a first fluid inlet port and second fluid outlet port;

a second end cap assembly having a third fluid inlet port and a fourth fluid outlet port; and

a plurality of bi-polar electrode plate assemblies interposed between the first and second end cap assemblies, wherein each of the bi-polar plate assemblies comprises an anodic electrode structure bonded together with an opposing cathodic electrode structure, wherein the anodic electrode structure comprises (i) one or more anodic fluid delivery channels positioned on a first side of the anodic electrode structure, (ii) one or more anodic fluid removal channels positioned on a second side of the anodic electrode structure, wherein the second side is substantially parallel to the first side of the anodic electrode structure, and (iii) one or more porous bulk matrix anodic fluid transport regions, wherein each porous bulk matrix anodic fluid transport region is positioned in between at least (a) one of the one or more anodic fluid delivery channels, and (b) one of the one or more cathodic fluid removal channels, and wherein each porous bulk matrix anodic fluid transport region is in fluidic communication with at least one of the one or more anodic fluid delivery channels and at least one of the one or more anodic fluid removal channels; and wherein the cathodic electrode assembly comprises at least one porous bulk matrix cathodic fluid transport region in fluidic communication with an inlet passage and an outlet passage, wherein the porous bulk matrix cathodic fluid transport region is adapted to hydrodynamically flow a gas or liquid therethrough, and wherein the porous bulk cathodic matrix fluid transport region is in fluid communication with the inlet passage and the outlet passage.

17. A fuel cell system comprising:

an anode derived from a first planar silicon substrate;

a cathode derived from a second planar silicon substrate; and

a liquid electrolyte that ionically connects the anode to the cathode;

wherein the anode and the cathode are spaced apart and substantially parallel to each other so as to define a spaced apart region, and wherein the liquid electrolyte is interposed between the anode and the cathode and within the spaced apart region.

18. The fuel cell system of claim 17 wherein the first and second planar silicon substrates are silicon wafers.

19. The fuel cell system of claim 18, further comprising a blocking media that is substantially impermeable to at least methanol and is substantially permeable to hydrogen atoms, wherein the blocking media is interposed between the anode and the cathode.

20. The fuel cell system of claim 19 wherein the blocking media is integrally connected to the cathode.

21. The fuel cell system of claim 19 wherein the blocking media comprises a metallic membrane.

22. The fuel cell system of claim 19 wherein the blocking media comprises palladium, niobium, tantalum, vanadium, or a combination thereof.

23. The fuel cell system of claim 17 wherein the anode has a plurality of integral anodic flow channels.

24. The fuel cell system of claim 17 wherein the anode has a plurality of anodic porous regions.

25. The fuel cell system of claim 24 wherein the plurality of anodic porous regions each comprise a plurality of mesoporous anodic pores, macroporous anodic pores, or a combination thereof.

26. The fuel cell system of claim 24 wherein the plurality of anodic porous regions each comprise a plurality of interconnected mesoporous anodic pores, wherein the plurality of interconnected mesoporous anodic pores are acicular and substantially parallel to one another.

27. The fuel cell system of claim 24 wherein the plurality of anodic porous regions have anode pore surfaces, wherein the anode pore surfaces have a catalyst thereon.

28. The fuel cell system of claim 27 wherein the catalyst comprises a plurality of noncontiguous chemisorbed metallic particles.

29. The fuel cell system of claim 27 wherein the catalyst is a chemisorbed bi-metallic catalyst derived from platinum and ruthenium precursors.

30. The fuel cell system of claim 17 wherein the cathode has a plurality of integral cathodic flow channels.

31. The fuel cell system of claim 17 wherein the cathode has a plurality of cathodic porous regions.

32. The fuel cell system of claim 31 wherein the plurality of porous cathode regions each comprise a plurality of mesoporous cathodic pores, macroporous cathodic pores, or a combination thereof.

33. The fuel cell system of claim 31 wherein the plurality of cathodic porous regions each comprise a plurality of interconnected mesoporous cathodic pores, wherein the plurality of interconnected cathodic mesoporous pores are acicular and substantially parallel to one another.

34. The fuel cell system of claim 31 wherein the plurality of porous regions of the cathode contain cathode pore surfaces, wherein the cathode pore surfaces have a catalyst thereon.

35. The fuel cell system of claim 34 wherein the catalyst comprises a plurality of noncontiguous chemisorbed metallic particles.

36. The fuel cell system of claim 35 wherein the catalyst comprises a chemisorbed metallic catalyst derived from a platinum precursor.

37. The fuel cell system of claim 17 wherein the electrolyte comprises a solution of water, an organic fuel, and an acid.

38. The fuel cell system of claim 37 wherein the organic fuel comprises an alcohol selected from the group consisting ethanol, propanol, methanol, or a combination thereof.

39. The fuel cell system of claim 37 wherein the acid is phosphoric acid, sulfuric acid, or a combination thereof.

40. A fuel cell system comprising:

a porous anode structure;

a porous cathode structure; and

a liquid fuel and electrolyte mixture that ionically connects the anode to the cathode;

wherein the anode structure and the cathode structure are spaced apart and substantially parallel to each other so as to define a spaced apart region, and wherein the liquid fuel and electrolyte mixture is interposed between the anode structure and the cathode structure and within the spaced apart region, and wherein the porous anode structure is in fluid communication with the spaced apart region and is adapted to flow the liquid fuel and electrolyte mixture therethrough, and wherein the porous anode structure has inner pore surfaces that have (i) a catalyst uniformly deposited thereon, and (ii) a polymeric catalyst uniformly deposited thereon.